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ABSTRACT

The purpose of the study was to identify and analyze the scientific elements of the creationist position, and to provide information and recommendations to educators facing the question of adding creationism to the science curriculum. The claim that creationism is of equal scientific status with evolution is examined in the first part of the study. Factors considered included the criteria for a scientific theory and the role of the supernatural in science. The remainder of the study is divided according to the five major areas of disagreement between the models of the creationists and the evolutionists: the origin of the universe; the origin of life; the origin of variability; the origin of man; and earth's geology and chronology. The key creationist claim is that creationism is deserving of equal status with evolution. If they can show that creationism should be elevated to the level of a scientific theory, or that evolution should be demoted to the level of a faith-based model, equal time in the curriculum becomes a fait accompli. However, they failed to do this, and therefore the study recommends that legislatures, school boards, and individual teachers refuse requests to add scientific creationism to the science curriculum as an alternative model to evolution. Any consideration of the doctrine of special creation should be in the context of a comparative study of religions, a history of religion, a history of science, or philosophy. (Author/RM)

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THE SCIENTIFIC CREATIONIST CHALLENGE TO THE TREATMENT OF EVOLUTION IN THE PUBLIC SCHOOL CURRICULUM

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SO 013 412

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INTRODUCTION

Evolution is considered by biologists to be the most significant idea in their discipline, and one of the best-verified as well. Evolution is the unifying concept which makes sense out of the variety, complexity, and dynamism of the living world (Glass 1967, Dobzhansky 1973. Mayr 1978, Bentley 1981).

However, evolution has never achieved the same status in the teaching of biology as it has in the practice of biology (Troost 1969). Only since the 1960's has evolution been a significant element in secondary biology texts (Skoog 1979). Nor has the overwhelming acceptance of the evolutionary view among scientists carried over to students, the general public, or even biology teachers (Troost 1969, Wade 1972, Weinberg 1978).

The validity of evolution and its presence and treatment in the public schools' curricula are currently under vigorous attack by a group of antievolutionists who call themselves scientific creationists:

> Presentation of the general theory of evolution as fact has no basis in science. The general theory of evolution (or general evolution model) is totally without foundation in physical evidence. (Moore 1973:24)

> The creation model postulates an omnipotent, omniscient, personal, purposive, moral Creator who created all things, including man. Unlike the evolution model, the creation model recognizes the scientific law of cause and effect. . .The creation model, supplemented

> by the cataclysmic model, fits all of the real facts of every field of science and every aspect of experience with a far better degree of correlation than does the evolution model. (Morris 1974:201)

> [Evolution's] applications in social and political thinking have been mainly responsible for the vast movements of economic and military imperialism, for the spreading influence of communism, for the many forms of virulent racism, for anarchism, for the various animalistic psychologies, and for the growing cancer of practical atheism and materialism in all aspects of modern life. (Morris 1977:191)

The two common themes found in creationist literature are the viability of creationism as a scientific alternative to evolution and the falsity of evolutionary theory. The creationists' ostensible goal is to gain equal time in science classrooms for their model (Bird 1980). Their ultimate goal is to eliminate evolution from the schools and the theory's influences from society (Parker 1979, Skoog 1980, Pearson 1981). Compromise seems unlikely, for according to Morris ". . .Satan himself is the originator of the concept of evolution" (1977:75).

FACTORS IN THE CURRENT CONTROVERSY

The post-Sputnik science curriculum reform, and in particular the evolution-oriented BSCS biology texts introduced in the early 1960's, provided the motivation for a revival of the opposition to evolution that began with the publication of Darwin's Origin of Species in 1859 (Morris 1977, Skoog 1978). Recently founded creation-science organizations,

especially the Creation Research Society and the Institute for Creation Research (see Appendix A), have provided leadership and added a new sophistication to old arguments.

Strong informal support for the creationists has come from fundamentalist Protestant denominations, which have been of late the fastest-growing religious groups in the U.S. (Nelkin 1976). Candidate Ronald Reagan provided creationism with moral support and nationwide publicity in 1980 when he expressed doubts about evolution and opined that creation should get equal time in the schools ("Republican Candidate..." 1980).

The creationist message is carried to the public by fundamentalist ministers, a national radio show, speakers' tours, newsletter, books aimed at non-scientists and children, and public debates at colleges and universities (Acts and Facts 1980). To promote legislation requiring equal time for creationism, the creationists have formulated a model bill and appeared as expert witnesses when such bills are considered. Other efforts aimed at the schools include conducting teacher workshops on the two-model approach, publishing creationist texts and teaching materials, and monitoring textbook content and text adoption proceedings. The creationists' multidimensional strategy has placed pressure on publishers, state and local school boards, and state legislatures, and through them on the individual teacher.

The most visible opposition to the creationists has come from the National Association of Biology Teachers, though

individual scientists have begun to challenge creationist claims ("Taking Time..." 1980). A group of Nobel laureates in science has expressed condemnation of creationism (Appleman 1979), and scientific societies such as the AAAS have issued resolutions opposing any introduction of creationism into science classes ("Resolutions of Learned..." 1973). State and Federal courts have played a major role, finding antievolution and equal-time laws unconstitutional and preventing the use of a creationist high-school biology text in Indiana public schools.

Recent creationist successes included an equal-time law scheduled to take effect in Arkansas in 1982, prohibitions on the presentation of evolution as fact in Texas and California, and a reduction in the amount of emphasis given to evolution in the texts of several major publishers (who have begun to view a hard-line evolutionary stance as economic suicide--Pilts 1980, Gorman 1980).

STATEMENT OF THE PROBLEM

Educators and legislators have come under intense pressure from a special-interest group to alter the public school science curriculum by adding scientific creationism and giving it time and treatment commensurate with that received by evolution. Most scientists find the creationist model meritless. However, in most cases non-scientists will decide whether to resist or accede to the creationist demands.

PURPOSE OF THE STUDY

The purpose of the study was to identify and analyze the scientific elements of the creationist position, and thereby to provide information and recommendations to educators and others facing the question of adding creationism to the science curriculum.

ORGANIZATION OF THE STUDY

The claim that creationism is of equal scientific status with evolution was examined in the first part of the study. Factors considered included the criteria for a scientific theory and the role of the supernatural in science.

The remainder of the study is divided according to the five major areas of disagreement between the models: the origin of the universe, the origin of life, the origin of variability, the origin of man, and earth's geology and chronology.

The annotations are arranged in accordance with the following priorities:

--creationist arguments are presented first within each section;

--where annotations are related, they are arranged according to the logical development of the argument; elsewhere, they are arranged alphabetically.

LIMITATIONS OF THE STUDY

The burden of proof was assumed to be on the creationists, inasmuch as they represent the minority view. Therefore every attempt was made to present a comprehensive picture of the creationist position as advanced by the ICR, CRS, and their members. The evolutionary citations were selected for their rebuttal value, and are not intended to provide a similarly comprehensive presentation of evolution. The evolutionary literature is vastly more extensive than the creationist literature, and a thorough review of the former was outside the scope and intent of this study. Readers seeking such a presentation or review are recommended to Dobzhansky 1977.

GLOSSARY

AAAS -- American Association for the Advancement of Science (see Appendix A).

amino acids -- "a group of nitrogenous organic compounds that serve as units of structure of the proteins," (Webster 1977:58).

ATP -- adenosine triphosphate. A chemical which is found in every living cell and serves as the immediate source of energy for cellular activity (after Moore, J.A.:139).

BSCS -- Biological Sciences Curriculum Study (see Appendix A).

catastrophism -- "the theory that geological changes are the rsult of sudden and violent physical causes," (Webster 1977:284). Also, "the doctrine that at least on the occasions mentioned in Scripture, God has directly intervened in the normal physical processes of the universe, causing significant changes therein for a time," (Whitcomb and Morris:xxi).

creationism -- "the doctrine that ascribes the origin of matter and of distinct species of animals and plants to acts of creation by God," (Webster 1977:427). Synonyms: theory of special creation, creation model. See also: scientific creationism.

CRS -- Creation Research Society (see Appendix A).

CSRC -- Creation Science Research Center (see Appendix A).

DNA -- deoxyribonucleic acid. "Any of various nucleic acids that are. . .the molecular basis of heredity," (Webster 1973:335).

entropy -- "a measure of the degree of disorder in a substance or system," (Webster 1977:608). Also, "a measure of the unavailable energy in a closed thermodynamic system," (Webster 1973:381).

enzyme -- "any of numerous complex proteins that are produced by living cells and [facilitate] specific biochemical reactions at body temperatures," (Webster 1973:382).

evolution -- "a series of partial or complete and irreversible transformations of the genetic composition of populations, based principally upon altered interactions with their environment. . .These adaptive changes occasionally give rise to greater complexity," (Dobzhansky 1977:8).

ICR -- Institute For Creation Research (see Appendix A).

macroevolution-- "evolutionary change involving relatively large and complex steps," (Webster 1973:689). As used by creationists, a synonym for species-formation.

microevolution -- "evolutionary change resulting from selective accumulation of minute variations," (Webster 1973:726). As used by creationists, a synonym for natural selection.

morphology -- "a branch of biology that deals with the form and structure of plants and animals," (Webster 1973:749).

NABT -- National Association of Biology Teachers (see Appendix A).

natural selection -- "that process in nature by which individuals (of a species) best fitted for the conditions in which they are placed survive, propagate, and spread; survival of the fittest," (Webster 1977:1197).

non-reciprocal altruism -- a structure or behavior in an organism (the altruist) which provides a benefit to another organism (the recipient) at some cost to the altruist, and is not reciprocated by the recipient during the course of the organisms' relationship (after Trivers:35 and Dobzhansky 1977:126).

Occam's razor -- "a scientific and philosophic rule requiring that the simplest of competing theories be preferred to the more complex, or that explanations of unknown phenomena be sought first in terms of known quantities," (Webster 1973:793).

paleontology -- "the study of fossils,' (Considine:1709).

phyla -- pl. of phylum. The second level in the hierarchy of biological classification (kingdom, phylum, class, order, family, genus, species).

phylogeny -- "the evolutionary development of any plant or animal species," (Webster 1977:1353).

plate tectonics -- "in geology, the theory that the earth's surface consists of plates, or large crustal slabs, whose [slow] constant motion acccunts for continental drift, mountain building, etc.," (Webster 1977:1376).

primate -- "any of an order (Primates) of mammals comprising man together with the apes, monkeys, and related forms (such as lemurs and tarsiers)," (Webster 1973:914).

radiometric dating -- "the measurement of geologic time by means of the rate of disintegration of radioactive elements," (Webster 1973:952).

RNA -- ribonucleic acid. Any of various nucleic acids which control the synthesis of protein in accordance with the information encoded in DNA.

scientific creationism -- "the scientific model of a recent, supernatural creation of the Universe and all its base components by a transcendent Creator," (Morris, quoted in Hatfield 1979:96). See also creationism.

secular humanism -- "a philosophy that asserts the dignity and worth of man and his capacity for self-realization through reason and that. . .rejects supernaturalism," (Webster 1973:556).

serology -- the study of blood and other body serums.

teleology -- "a belief. . .that natural phenomena are determined not only by mechanical causes but by an over-all design or purpose in nature; opposed to mechanism," (Webster 1977:1874).

thermodynamics -- "the science that deals with the relationship of heat and mechanical energy and the conversion of one into the other," (Webster 1977:1894).

uniformitarianism -- "a geologic doctrine that existing processes acting in the same manner as at present are sufficient to account for all geological changes," (Webster 1973: 1279). Synonym: Principle of Uniformity.

ANNOTATIONS

THE NATURE OF SCIENCE, SCIENTIFIC THEORY, AND SCIENTIFIC FACT

Creationist Viewpoint

Moore, John N., "Evolutionist-Creationist Round-table: John N. Moore," The Science Teacher 43:35,38, November, 1976.

Moore asserted that true science requires repeatable observations (experiments). The morphological, embryological, anatomical, and biochemical evidence for evolution is circumstantial and irrelevant. Moore concluded that evolution is not true science. In comparing evolution and creation models, only fossils and genetic experiments provide useful evidence. Both support the creationist concept of "fixity of kinds", according to Moore. Proponents of evolution are invoking the supernatural when they refer to spontaneous generation of life or to the rise of new traits through mutation. Moore argued that presenting evolution exclusively amounts to the indoctrination of children. Proper exercise of academic freedom and professional responsibility demand that both models be presented.
[Moore is a director of the CRS and coeditor of its journal.]

Moore, John N., "Evolution, Creation, and the Scientific Method," The American Biology Teacher 35:23-26, January, 1973

Moore proposed three criteria for evaluating a scientific theory. First, it should be useful for organizing diverse data. Second, it should be able to adapt to new data. Finally, it should be useful in making predictions. Moore asserted that while the theory of natural selection fits these criteria, the general theory of evolution (macroevolution) does not. Natural selection, though demonstrable, does not constitute proof of evolution. According to Moore, science is a search for observable facts through experiment. Moore distinguished between circumstantial and conclusive evidence; only experiments can provide the latter. Evolution is not repeatable, was not observed directly, and therefore is supported only by circumstantial evidence.

Bird, Wendell R., "Creationism and Evolution," Educational Leadership 38:157, November, 1980.

According to Bird, scientific creationism can be taught without reference to the Bible or theology, and consists of evidence from several scientific disciplines. In his view, neither evolution nor scientific creationism is religious. However, because neither can be experimentally verified, both require faith. Bird called natural selection a teleology equivalent to design in the creation model. Evolution assumes the existance of matter just as creationism assumes the existance of a creator. [Bird did not acknowledge that the existance of matter is self-evident.] Bird stated that the equal standing of the models requires us in good faith to give them equal treatment. Bird asserted that scientific creationism has been suppressed by mainstream science journals.
[Bird is the ICR's staff attorney.]

Gish, Duane T., "Creation, Evolution, and the Historical Evidence," The American Biology Teacher 35:132-140, March, 1973.

Gish ennumerated three criteria for a scientific theory: it must be supported by observable events or processes, be useful in making predictions, and be capable of being falsified by some test or observation. [The last criterion is borrowed from, but not credited to, Popper (see next entry).] Gish conceded that creationism does not meet these criteria, and asserted the evolution does not either. Evolutionary theory has been made "plastic" and can explain anything. Gish argued that, since no macroevolution has been observed, and since extrapolation from microevolution is invalid, evolution is "unproven and unprovable" (p. 134). Gish contends that evolution's wide acceptance is the result of philosophic biases against creationism, and that current teaching practices amount to indoctrinating students in the philosophy of secular humanism.
[Gish is Associate Director of the ICR.]

Popper, Karl R., The Logic of Scientific Discovery, Basic Books, Inc., New York, 1961, 480 pp.

Popper proposed that all meaningful statements in science must be capable of being "finally decided;" that is, it must be possible both to verify and to falsify them. Theories are never verifiable, because it is logically impermissible to prove general principles from specific cases. Therefore, for a theory or system to be scientific it must be falsifiable (i.e., refutable by experience). Popper further defined true empiricism (i.e., science) as a process of exposing a theory to every possible means of falsification, with the result that only good theories are retained. Popper acknowledged, however, that falsifiability is a matter of degree, and explored a mathematical framework for comparing two theories on that basis.
[Popper's book is regarded as a major work in the philosophy of science.]

Evolutionist Viewpoint

Alexander, Richard D., "Evolution, Creation, and Biology Teaching," The American Biology Teacher 40:91-104, February, 1978.

Alexander stated that the comparative method (observation) and the experimental method are fundamentally identical, differing only in the degree of control and manipulation. Both methods can give precise results, and to call one type of evidence circumstantial and the other conclusive is to set up a false dichotomy. Moreover, science produces statements in which we have a certain degree of confidence (expressed by the .05 and .01 levels in statistics), rather than immutable facts. Alexander reported that Darwin provided the key to falsifying evolution: it should explain everything observable, but not everything imaginable (e.g., non-reciprocal altruism). Creationists must give creation the status of a falsifiable idea, but have not, argued Alexander. He stated that evolutionary theory is complex and vulnerable to distortion, has been tested by many skeptical investigators, and is prestigious because it is powerful.

Anderson, Wyatt W., "Evolutionist-Creationist Round-Table: Wyatt W. Anderson," The Science Teacher 43:34,36-37, November, 1976.

Anderson pointed out that the central tenet of special creation (that the Genesis account is literally accurate) is under no circumstances amendable: the data must adapt to the hypothesis. This is unscientific methodology, and makes special creation unfalsifiable. Anderson concludes that special creation is not a scientific model or theory, and should not be included in science curricula. Anderson viewed the creationist requirement that evolution produce testable hypotheses about long-term processes as unduly restrictive, and pointed out that in certain fields experimental testing of predictions is limited: when dealing with past events, long-term events, small objects, and fast processes. However, Anderson stated that evolutionary theory is being tested in a number of ways, including the correlation of biochemical, fossil, and genetic data.

Gould, Stephan Jay, "Evolution as Fact and Theory," Discover 2:34-37, May, 1981.

Gould contended that evolution is both a fact and a falsifiable theory. Facts are data. Theories are idea structures which explain and integrate facts. Creationists confuse the common meaning of theory (imperfect fact) with its scientific meaning. Moreover, facts are not absolutes except in the idealized disciplines of logic and mathematics. Empirical facts are provisional to a degree, and evolutionists do not claim to represent perpetual truth. Gould stated that since the time of Darwin, evolutionists have made a distinction between the fact of evolution and the theories which explain it. The current debate in biology, which has been used by creationists to attempt to falsify evolution, is not over the fact of evolution but the details of its processes. Gould stated that all existing theories of evolution are potentially falsifiable, and chided creationists for using Popper's model selectively in that they have not proposed a falsifiable alternative to evolution.
[Gould is frequently quoted in creationist publications, and he accused them of, through ignorance or design, misrepresenting his views.]

Hanson, Earl D., "Back to Position One in the Textbook Controversy," The American Biology Teacher 39:248-249, April, 1977.

According to Hanson, natural selection is the essential theoretical postulate of evolution and is testable. Phylogeny, diversity, and accumulated changes are all results of natural selection. Predictions must be made from the processes, not from the end results. Predictions based on natural selection have been verified in many organisms: bacteria, algae, higher plants, and higher animals. Since natural selection is testable, it is falsifiable. Since natural selection is the central process of evolution, evolution is a scientific theory by Popper's criterion.

Kyle, William C., Jr., "Should 'Scientific' Creation and the Science of Evolution Be Taught With Equal Emphasis?" Journal of Research in Science Teaching 17:519-527, November, 1980.

Kyle noted that nothing is science is deemed absolute. Science attempts to organize and explain phenomena, rather than to discover "truths." Scientists try to be objective, and observations should be verifiable by others using the same techniques. Forming general principles and theories from data on specific problems or cases is permissible as long as the theories are seen as amendable and expendable. Scientists must rely on material and mechanical, rather than supernatural, explanations, and must eschew teleology. Such restrictions are what make science a productive endeavor. Kyle acknowledged that the creationist view may be perfectly true; however, since creationists can explain any phenomenon by appealing to God's powers, creationism is at heart nonscientific.

Mayer, William V., "The Incompatibility of Science and the Supernatural," Educational Leadership 38:158-159, November, 1980.

Mayer argues that the introduction of supernatural explanations to science is unsound and invalid. Theories must be capable of being revised or rejected; creationism allows for neither. The appropriate place in the schools for creationism is in courses in comparative religion, in Mayer's view. Creationists oppose such courses and seek an exclusive position for their minority doctrine in the classroom. The appeal to the supernatural and the reliance on immutable assumptions, argued Mayer, make the creationist position completely unscientific.
[Mayer is Director of the BSCS.]

Patterson, Colin, Evolution, Cornell University Press, Ithaca, New York, 1978, 197 pp.

In evaluating evolutionary theory on Popper's terms, Patterson distinguished between the idea that evolution has occurred and natural selection as the cause of that evolution. He called the former a historical theory about unique events. Even though the theory must be consistent with genetics, homology, and Occam's razor, there are no laws of evolution comparable to the laws of physics; past evolution cannot be explained and future evolution cannot be predicted. Patterson concluded that the idea of evolution is neither fully scientific nor unscientific. It lacks laws, but has rules and makes general predictions. It is open to disproof, as even Darwin recognized. Genetics, the earth's age, DNA, and biochemistry have provided severe tests. Natural selection, however, becomes non-falsifiable with the addition of the idea of genetic drift (non-selected features). Patterson observed that evolution is and has been a fruitful theory and a stimulus to thought and research.

Peters, Walter G., III, "Fundamentalist Scientists Oppose Darwinian Evolution," BioScience 20:1067-1069, October 1, 1970.

In examining the creationists' claim of representing a scientific rather than religious idea, Peters reviewed the CRS credo. In that credo, the creationists identified several operating assumptions: (1) the Bible is the written word of God and is infallible scientifically and historically; (2) the description in Genesis of the origin of the universe and life is literal and factual; (3) all biological change since the creation has been within the created kinds. Peters reported that the CRS's goals are a re-evaluation of science from a creationist perspective, and an eventual realignment of science.

"Resolutions of Learned Societies in the Textbook Controversy," The American Biology Teacher 35:35-36, January, 1973.

Reprinted here are the texts of resolutions in response to a proposal in California to give creation "equal time" with evolution. The AAAS's Commission on Science Education cited a century and a half of study of the earth's crust, fossils, genetics, and physiology as the foundation for concluding that present life evolved from different species that lived in the past, and stated that there is no acceptable scientific alternative to evolution. The National Academy of Sciences stated that the scientific method excludes appeals to supernatural causes, and called religion and science "mutually exclusive realms of thought."

Walker, Richard A., Mertens, Thomas R., and Hendrix, Jon R., "Clarifying the Creation-Evolution Issue With Biology Students," The American Biology Teacher 39:49-51, January, 1977.

According to the authors, scientists assume that nature is reality, while the theist sees reality as the natural world plus the supernatural. Scientific truth is always relative, while theistic truth is absolute. Failure to define terms and recognize distinctions such as the above prevent meaningful discussion. In the authors' view, absolute truths cannot be tested by science since all observations must be explained in terms of those unchanging referents, while scientific truths will be modified to account for new data. The authors defined evolution as a process of changing gene frequencies through natural selection, and stated that it has been empirically documented. Evolutionary schemes (phylogenies) are constructs based on data from biochemistry, genetics, embryology, morphology, serology, and paleontology. The discovery of errors in or a lack of data for such schemes does not invalidate evolution as a process.
[Parker 1977 is a response to this article by one of Mertens' former students.]

Legal Perspectives

LeClercq, Frederic S., "The Constitution and Creationism," The American Biology Teacher 36:139-145, March, 1974.

LeClercq reported that the evolution/creation question involves the Establishment and Free Exercise clauses of the First Amendment to the U.S. Constitution. In Epperson v. Arkansas (1968), an antievolution statute was revoked because it was based solely on the religious views of one group. The "equal-time" movement is seen by LeClercq as a change in strategy in response to Epperson. But special creation, even without Biblical referents, is a supernatural doctrine and the teaching of it conflicts with the First Amendment. There may be grounds under the Free Exercise clause to exempt students from the study of evolution, which could forestall efforts to compromise texts. The Due Process clause of the Fourteenth Amendment guarantees a student the right of access to knowledge. Requiring the teaching of creationism violates the academic freedom and "marketplace of ideas" aspects of the First Amendment.
[LeClercq represented the NABT in a successful 1975 suit against a Tennessee equal-time law (see Appendix C).]

Skoog, Gerald, "Legal Issues Involved in Evolution Vs. Creationism," Educational Leadership 38:154-156, November, 1980.

According to Skoog, U.S. courts have consistently found efforts to forbid the teaching of evolution or to mandate the teaching of creationism unconstitutional. A 1973 Tennessee law was found to give preference to a particular religious doctrine. In 1977, adoption in Indiana of the creationist biology text (Moore and Slusher 1974) was prohibited on the basis of excessive entanglement with and promotion of fundamentalist doctrine. Scientific creationism is also seen by legal experts as having an inherent religious basis, though a definitive court test has not taken place. Suits claiming that the exclusive teaching of evolution abridges the Free Exercise rights of students have not been successful. Suits claiming that evolution is a religious theory (secular humanism, agnosticism, or atheism) have not been successful. Special creation and evolution have been seen by the courts as separate and not equal.

THE ORIGIN OF THE UNIVERSE

The Argument From Design

Morrison, Abraham Cressy, Man Does Not Stand Alone, Fleming H. Revell Co., New York, 1946, 105 pp.

If the earth rotated more slowly, its flora would burn up during the day and freeze at night. If the sun were warmer or cooler or the earth closer to or farther away from it, Earth would be uninhabitable. If the earth were not tilted 23° from the vertical, our continents would be covered with ice. If the moon were closer, the tides would submerge the land and erode the mountains. If the crust of the earth were thicker, there would be no oxygen in our atmosphere [other scientists would dispute this]. If our atmosphere were thinner, meteors would be constantly starting fires as they struck the surface. Morrison asserted that these and other similar facts prove that life on earth is not an accident and must have been planned. According to Morrison, the migration of eels, the complexity of genes, and the existance of natural enemies are evidence of design.
[Morrison predates scientific creationism. However, his book remained in print into the 1970's and modern creationists cite it and echo his arguments.]

Gish, Duane T., Have You Been...Brainwashed?, Life Messengers, Seattle, Washington, 1974, 30 pp.

This cartoon-like booklet summarized a presentation by Gish at the University of California at Davis. Following a discussion of fossils, Gish pointed out that if the earth were ten percent larger or smaller, no life as we know it would be possible. If the earth's average temperature were three degrees higher, melting glaciers would flood major cities and much of the most fertile farmland. If the ozone layer were not there, "eight killer rays" would wipe out life on earth. The existance of a liquid ocean on earth is a "miracle." The precision of the earth's orbit around the sun could only be achieved by "an infinite God." Gish concluded that Genesis is still the most up-to-date statement on origins.

Parker, Gary E., "Clarifying Creation-Evolution," The American Biology Teacher 39:247, April, 1977.

When an archeologist finds an unusual object (for instance, a piece of hardened clay with patterned stains), s/he can conclude it was created, even if no information about the creator is available. According to Parker, a scientist observing the operation or structure of a living system can reasonably come to the same conclusion. [The archeologist is extrapolating from the known fact that people make pottery; the cases are not analogous.] Though a "restrictive materialistic philosophy" rules out supernatural forces, "open-ended scientific methodology" does not. The fact of creation can be recognized even if the agent of creation remains a matter for faith.
[Parker is a research associate with the ICR.]

Aulie, Richard P., "The Doctrine of Special Creation," The American Biology Teacher 34:191-200, April, 1972.

Aulie examined the argument from design as found in the creationist biology text (Moore and Slusher 1974), where the following were offered as evidence: direction of plant growth; human vision; sexual reproduction of bacteria; flowers; bird songs; and various animal behaviors. Aulie noted that design is often suggested when the observer experiences a sense of wonder. Design is perceived because of our thinking processes, and not necessarily because of the observed objects themselves. The argument from design breaks biology into unrelated collections of facts and destroys cause-and-effect relationships, according to Aulie.

Stebbins, G. Ledyard, "The Evolution of Design," The American Biology Teacher 35:57-61, February, 1973.

Stebbins pointed out that design by a creator and design by random chance are not the only possibilities. Some designs exist because of the symmetry of the molecules that make up the material. Functional designs are refinements of preexisting designs which can be traced back to the properties of inorganic molecules. The shape of a snowflake is an example of a molecule-symmetry design. The apparently complex design of some spiderwebs is just one of many variations on a theme, from spiders who lay barbed-wire-like threads irregularly around a burrow to those that spin no webs at all. Each variation has functional and adaptive value. Natural selection acts as an antichance factor to accept or eliminate modifications that arise by chance. The present complexity of some life does not mean life had to start at that level of complexity. Moreover, a simple structure requires less precision in coding the "plan" (into genes, for instance), and allows for more variations (mistakes) being functional. Early evolutionary designs were probably less impressive.

Lewontin, Richard C., "Adaptation," Scientific American 239: 212-230, September, 1978.

Lewontin stated that "perfect" organs such as the human eye are the extremes in a range of adaptations. Adaptation is a solution by an organism to a problem posed by the environment. The framework for the problem is the ecological niche, which includes temperature, moisture, food sources, predators, behavior, and social organization. There is a constant and complex interplay between the organism and the environment. Adaptation does not necessarily improve an organism, according to Lewontin. In many if not most cases adaptation merely allows the organism to continue to survive in the face of change (a kind of biologic running-in-place). What we perceive as design is imposed not by a deity but by the demands of the environment.

The Argument From Authority

Riegle, David D., Creation or Evolution?, Zondervan Publishing House, Grand Rapids, Michigan, 1972, 94 pp.

In this book intended for junior high students, Riegle argued that the creation stories in Genesis represent the inspired word of God as recorded by Moses. Genesis is clear, precise, unchanging, and "the simple truth." Man could not have evolved, asserted Riegle, because the Bible clearly says the first humans were directly created by God in His own image. Genesis also describes the creation of the stars, planet Earth, solar system, sun, and oceans in a way that leaves "no room for speculation or theory." The days of the Creation week were 24-hour solar days, according to Riegle. [Strict scientific creationists minimize the argument from authority in their works, but it is still present. CRS members must affirm their belief in the literal truth of the Bible when they join.]

Parker, Barbara, "The Genesis Account Is Not The Only Explanation of Creation," The American School Board Journal 167:34, March, 1980.

According to Parker, the problem with an argument from authority is that there are a number of conflicting authorities --the religious traditions of various human cultures. In the Japanese Shinto faith, Parker reported, a pair of kami (divine powers) are said to have given birth to the Japanese islands and to other kami, who in turn started the various family clans. The Buddhist belief is that the universe is uncreated, without beginning or end, and that there is a repeating pattern of "origination, duration, destruction, and annihilation." Hinduism is pantheistic: the ultimate reality known as Brahman is the cause, the substance, and the spirit of all things.

Kenyon, Kathleen M., The Bible and Recent Archaeology, John Knox Press, Atlanta, Georgia, 1978, 105 pp.

Kenyon reported that the vast majority of Bible scholars agree that the first five books of the Bible are a compilation of oral and tribal records over a long period of time. "Invented pedigrees and anachronisms" are typical of such records. Three separate elements (writers or sources) can be identified: one dating from the 10th century B.C., one from the 8th century B.C., and the last circa 530 B.C. All of the elements were brought together in their present form no earlier than 300 B.C.

Speiser, Ephraim A., The Anchor Bible: Genesis. Doubleday, New York, 1964, 378 pp.

On the basis of vocabulary, style, content, and concepts, scholars consider the first book of the Bible to have at least three authors or sources. Due to a similar order of events and a "striking correspondence" in the details, the first creation story is believed to be borrowed from the Babylonian creation epic Enūma eliš. The second of the two creation stories in Genesis shows a complete change of viewpoint from heaven-centered to earth-centered, according to Speiser.

Cosmogony and Cosmology

The Holy Bible: Revised Standard Edition (With Helps), Thomas Nelson and Sons, New York, 1952, 981 pp.

The Genesis accounts of creation appear in Gen. 1-2:3 and Gen. 2:4-2:23. The former presents the following sequence: the creation of the heavens and earth (the latter being "without form"); first day, the creation of light and its separation from darkness to form night and day; second day, the creation of heaven; third day, the appearance of dry land and plants; fourth day, the creation of stars, the sun, and the moon; fifth day, birds and sea creatures; sixth day, land animals, man, and woman. The sequence in the second story is somewhat different: first the earth and the heavens, then man, then plants, then animals (to serve as man's helpers), and finally woman.

Jastrow, Robert, "Have Astronomers Found God?" The New York Times Magazine, June 25, 1978, p.19-24.

Jastrow noted that the reigning scientific theory of the origin of the universe (the big bang) has a parallel to the Biblical story of creation in that both postulate a sudden, definite beginning. Jastrow reports that the universe is observed to be expanding, and that Penzias and Wilson detected the background radiation from the primeval fireball in 1965. Jastrow noted that some astronomers have an emotional resistance to the idea of a universe with a beginning, in part because the nature of that cataclysm eliminates any chance of discovering what preceded it and why it occurred. Some believe that instead of expanding endlessly into a cold death, the universe will stop expanding (because of gravity), collapse again, and then rebound for a new cycle. Present data favors the big-bang theory over the oscillating universe theory.

Weinberg, Steven, The First Three Minutes, Bantam Books, New York, 1979, 177 pp.

Weinberg presented a detailed description of the standard model of the origin of the universe, which is widely accepted and used as the theoretical basis for astronomical observations and the test-bed for astrophysical ideas. According to the model, one-hundredth of a second after the big bang, the densely packed matter-energy of the universe was at a temperature of 100 billion degrees Celsius. All matter was in the form of elementary particles: electrons, positrons, and neutrinos. The universe was filled with light. As the universe expanded, it cooled, and eventually ordinary atomic particles could form. Near the end of the first three minutes, hydrogen and helium nuclei could form, and a few hundred thousand years later the universe had cooled to the point they could capture electrons and become atoms. Weinberg discussed the theoretical, experimental, and mathematical basis for the model, and anticipated that it will be revised as more research is done.

Sagan, Carl, Cosmos, Random House, New York, 1980, 365 pp.

Hydrogen and helium were the only elements formed in the big bang, Sagan stated. Small unconformities in the expanding matter grew due to gravity into vast clouds of gas, which continued to collapse and to heat up. As they condensed, they began to spin, in accordance with the laws of conservation. At various points in the cloud, temperatures and pressures reached the kindling point of stellar thermonuclear reactions. The hot young stars evolved rapidly, and died in supernova explosions. The explosions created shock waves in the proto-galaxy and accelerated the formation of stars by compressing the matter in the cloud. Lighter atoms (up to iron in the periodic chart), were formed inside stars during their lifetime. Heavier atoms were created under the stresses of the supernova explosion, which scattered all the star's material back into the galactic medium, making it available for the formation of planets. The sun is a second- or third-generation star.

THE ORIGIN OF LIFE

Probability and Thermodynamics

Bliss, Richard B., Origins--Two Models: Evolution/Creation, Creation-Life Publishers, San Diego, California, 1978, 59 pp.

According to Bliss, evolutionists say that the first cell (or self-reproducing molecule) came together by random chance. The formation of a particular protein of 200 amino acids, asserted Bliss, is a 1 in 10 to the 260th power probability. For comparison, Bliss noted that only 10 to the 130th power electrons could be packed into the volume of the known universe. Therefore, the formation of even one such molecule would be a miracle. [The assumptions and process from which this probability was derived are not presented. One necessary assumption is that all combinations of amino acids are equally likely--that the chemical structures neither favor nor prohibit any combinations. Bliss is the director of curriculum development for the ICR.]

Gish, Duane T., Creation, Evolution, and Public Education, monograph, Institute For Creation Research, San Diego, California, n.d., 13 pp.

The theory of evolution contradicts the inviolable Second Law of Thermodynamics (Entropy), claimed Gish. All natural systems go from order to disorder. Randomness increases. But evolution posits movement from disorder to order, toward greater complexity and reduced randomness, creating a basic contradiction. The evolutionist claim that the second law applies only to closed systems is naive, according to Gish. To form complex structures from simple, an energy conversion mechanism and a control mechanism are needed in addition to the outside energy source. Gish argued that a Creator must have provided these; machines are required to build machines, and Someone must operate the machinery. Evolution is anti-scientific, Gish stated, because of the contradiction of the Second Law.

Morris, Henry M., The Troubled Waters of Evolution, Creation-Life Publishers, San Diego, California, 1977, 217 pp.

Entropy makes the origin of life from non-living chemicals an impossibility. The argument that the sun provides the necessary energy is insufficient; there is no mechanism for using that energy, according to Morris. The exception to the law posed by living things is possible only through photosynthesis, which is too complex to have evolved. DNA and its replicating enzymes are complex and dependent on each other. Morris argued that they could not have formed by a fortuitous accident at the same time. Morris viewed the idea that chemicals have tendencies to form life molecules as the same as saying they contained a coded plan, which requires a Planner. Even the simplest life forms are too complex not to have been created.
[Morris blamed racism, the sexual revolution, and UFO cultism on evolutionary theory. He is the director of the ICR.]

Mahan, Bruce H., Elementary Chemical Thermodynamics, W.A. Benjamin, Inc., Menlo Park, California, 1964, 155 pp.

The Law of Entropy or Second Law explains the fact that natural processes or changes have a quality of direction which the Law of Conservation cannot explain. The entropy of a system never decreases, though under ideal conditions it could theoretically remain the same. Mahan emphasized that the law applies to systems; entropy is a mathematical construct requiring calculus. When applied mathematically (not verbally) to a closed system (not a portion), the Law of Entropy permits predictions for and explanations of spontaneous change in the Universe.

Asimov, Isaac, "The Judo Argument," in the collection The Planet That Wasn't, Avon Books, New York, 1976, 237 pp.

According to Asimov, the claim that probability precludes evolution contains logical errors. Calculations showing extremely low probabilities for the formation of a protein molecule by chance are based on the false assumption that atoms combine in absolutely random fashion. Their movement is random, but they combine according to the constraints set by the laws of physics and chemistry. Atoms have strong affinities for certain combinations, and the formation of complex life compounds is in fact a high probability event, as has been demonstrated experimentally. The combination of raw materials, energy, time, and chemical tendencies makes the formation of life almost inevitable.

Asimov, Isaac, Life and Energy, Avon Books, New York, 1972, 378 pp.

Only the net change in entropy is always positive, Asimov pointed out. Local decreases in entropy in one part of a system are common; they are more than balanced out by increased entropy in the rest of the system. A refrigerator or elevator appears to reverse the normal direction for the movement of heat or objects until the energy taken in by the motor is taken into account. Asimov suggested that a useful element of a definition for life would be the ability to bring about a local decrease in entropy, as an animal does by climbing or swimming to a higher level and as plants do by building up complex chemicals from simple ones. Nonliving agents can also do this, as in the example of a solution of simple molecules, irradiated with ultraviolet light, producing more complex (more ordered) molecules. Asimov concluded that thermodynamic laws pose no problem to either the formation of or the maintenance of life on earth.

Evidence For A Naturalistic Origin

Miller, Stanley, "The Formation of Organic Compounds on the Primitive Earth," Annals of the New York Academy of Science 69:260-275, 1957.

Miller described the procedure and results for a series of experiments simulating the origin of life in a primitive earth atmosphere. A mixture of hydrogen, methane, water, and ammonia was enclosed and circulated through a test chamber containing spark electrodes. After 160 hours with the spark at 60,000 volts (simulating lightning), the collection chamber was found to contain a variety of amino acids. Additional runs established that the compounds had been directly synthesized and the rate of their formation.

Fox, Sidney W., "From Inanimate Matter to Living Systems," The American Biology Teacher 43:127-135, March, 1981.

According to the model presented by Fox, there are five steps in the formation of life from inanimate matter: amino acids, proteinoids, protocells, light-active protocells, and nucleic acid protocells Repeated experiments have recreated the first two steps, and work continues on the last three. Proteinoids are biologically active, though not alive, and form from heating Miller-type amino acids to 65° C or less. Parts of the last three steps have been modeled by Fox, and no insurmountable problems have been identified. The reactions involved in forming amino acids and proteinoids have shown themselves to be nonrandom, and Fox asserted that probabilistic objections are not valid. In his view, the evolution of the first life was a series of small steps rather than a jump from lifeless chemicals to DNA.

Dickerson, Richard E., "Chemical Evolution and the Origin of Life," Scientific American 239:70-109, September, 1978.

Drawing on the work of Miller, Harold Urey, Fox, and Oparin, Dickerson detailed a probable course for the evolution of the first life from non-living materials. An oxygen-free atmosphere would be required, and many forms of energy would have been available on the primitive Earth to create organic molecules . Evidence for constructing a scenario for the origin of life comes from fossil microorganisms, geologic history, laboratory experiments, discovery of organic compounds in meteorites and interstellar dust, and studies of other terrestrial planets. Dickerson developed a twenty-step chemical sequence leading to the invention of photosynthesis, and discussed problems such as competition with water molecules. Oparin's experiments have shown how conglomerations of molecules can mimic photosynthesis and reproduction.

Schopf, J. William, "The Evolution of the Earliest Cells," Scientific American 239:110-139, September, 1978.

According to Schopf, the two major developments in cell evolution were the development of photosynthesis and the cell nucleus. Schopf presented a tentative outline of Precambrian evolution, in which the dominant organisms are microscopic and the rate of evolution is limited by the lack of sexual reproduction. The advances made were biochemical rather than structural. Many Precambrian microfossils have been found since 1968, and they provide information on the organism's size, structure, complexity, and, in rare cases, internal structure. Late Precambrian rocks contain fossil jellyfish, worms, and sponges, invalidating the argument that complicated life forms appear suddenly in the Cambrian with no predecessors.

THE ORIGIN OF VARIATION

Baramins and Fixity of Kinds

Gish, Duane T., "A Challenge To Neo-Darwinism," The American Biology Teacher 32:495-497, November, 1970.

According to Gish, the earliest indisputable fossils are found in Cambrian rocks, and no ancestors for these forms can be found in Precambrian rocks. All the major invertebrate phyla are represented in the Cambrian, and there are no transitional forms to show that these phyla had common ancestors. There are no transitional forms, Gish asserted, showing the origin of amphibians from fish, or documenting the evolution of flight in birds, insects, pterosaurs, or bats. Gish argues that the supposed bird transitional form, Archaeopteryx, is "undoubtedly" a bird. The sudden appearance of major groups and the lack of transitional forms support special creation.
[Gish's conclusions appear to be based not on original research or first-hand examination of the fossils but on library research; much of his evidence consists of snippets quoted from various evolutionists, a technique criticized by Gould (1981:37) and Dobzhansky (1973:129) among others.]

Gish, Duane T., Evolution--The Fossils Say NO!, Creation-Life Publishers, San Diego, California, 1978, 188 pp.

Gish claimed that the fossil record is rich and would show transitional forms if any existed, and questioned the existance of fossils in Precambrian rock. Gish asserted that mature forms appear suddenly in the Cambrian. There is a systematic lack of transitional forms. The transition from reptiles to mammals proposed by evolutionists is, according to Gish, wishful thinking. The proposed fish-to-amphibian transition is undocumented by transitional forms. Gish claimed that there are "tremendous gaps" between the flying reptiles and their supposed ancestors, and all of the major fish classes are distinct and without transitional forms.
[Again, Gish relies on argument-by-quotation, with the majority of his sources ten to fifteen years old or more. Moreover, even if one were to grant Gish his reinterpretation of what others view as transitional forms, there is still the real possibility that scarcity of transitional forms traces to the process of fossilization, the rate of diversification, or other naturalistic causes.]

Gish, Duane T., "The Origin of Mammals," Impact 87:1-8, September, 1980.

Gish stated that mammals cannot be linked through fossils to reptiles or any other group, and that there are no links between the 32 mammalian orders. Gish asserted that the laws of probability dictate that the majority of the 250,000 fossil species should be transitional forms, though he did not identify the reasoning that led to that conclusion. According to Gish, the well-known horse sequence--Eohippus to Miohippus to Merychippus to Equus--is a "scenario" without evidence because there are no links between the links. Observing that rodents are fecund, Gish argued that the fossil record of rodents should be replete with transitional forms--which he stated was not the case. Based on a prior assumption that humans were created separately, Gish quarreled with the inclusion of humans in the order Primates, and maintained that the origin of the Primates cannot be explained.

Lester, Lane P., "Evolutionist-Creationist Round-Table: Lane P. Lester," The Science Teacher 43:34, 36, November, 1976.

In the creationist model as described by Lester, God created a number of baramins--created kinds--each of which had built into it a degree of genetic variability, allowing the adaptive variation we see today. One such baramin produced horses, zebras, donkeys, and other genetically related animals. Therefore, rather than one enormous "tree of life," creationists envision a forest of small trees (each a baramin). Lester acknowledged this concept to be a retreat from the earlier contention that all species were separately created as we see them today, and failed to offer a means of identifying a baramin. Lester suggested that anyone who denies the existance of the supernatural cannot objectively review the evidence on origins, while those who accept the supernatural can explore the question scientifically.
[Lester is a CRS member.]

Moore, John N., and Slusher, Harold S., Biology: A Search For Order In Complexity, Zondervan Publishing Co., Grand Rapids, Michigan, 1974, 595 pp.

In this CRS secondary-school biology text, the authors opined that no plant type is more primitive or more advanced that any other. They are simply different created patterns. In the same way, a single blueprint was used for the seven vertebrate classes. The fact that less complex animals still exist and have not been pushed out by more complex animals was seen as refuting the theory of evolution. Citing an investigation in which various animal skulls were filled with beans to determine their capacity, the authors argued that despite being stupid the opossum has survived and increased its range, while evolution would predict it would become extinct. Hydra feeding on Daphnia and jack pines crowding out daisies were offered as additional examples of simple organisms selecting against complex ones.
[Evolution does not predict that more complex organisms will replace simpler ones. In some niches simplicity is a virtue. The examples given above are ecological phenomena, not evolutionary.]

Morris, Henry M., The Bible and Modern Science, Moody Press, Chicago, Illinois, 1968, 128 pp.

Morris noted that many species have remained unchanged through supposed millions of years, and asserted that if paleontologists weren't dishonest in assigning names to new fossils, more species would be recognized as having remained unchanged. Morris found the fact that protozoa still exist inexplicable, and suggested that many modern species are degenerate, rather than higher, forms of fossil species. Examples offered included elephants, wolves, insects, and reptiles ("compare the dinosaurs to our modern snakes and alligators. Some evolution!", p.46). [Morris did not define "degenerate," but smaller size seemed to be a common element in his examples.] Concerning the horse series, Morris stated that Eohippus was obviously a horse, and the loss of toes in the sequence leading to Equus is a deterioration, not an advance. Morris concluded that fixity of kinds is a real phenomena.
[Morris admitted that with the exception of humans, creationists cannot be sure what constitutes a "kind," yet in the next paragraph stated confidently that evolution across the kinds has never taken place.]

Darwin, Charles, The Origin of Species, The New American Library, Inc., New York, 1958, 479 pp.

Modern evolutionary theory began with the publication of this book in 1859, and the central concept of natural selection remains essentially unchanged from Darwin's elucidation of it. Specifically: all species produce more offspring than can survive. There is a high death rate, and therefore a struggle for survival (both within and between species). The competitors vary in many small characteristics and these variations affect the chances for survival. Only the best adapted, or fittest, survive to reproduce. The accumulation of variations, especially as the environment changes or the organism moves into a new range, gives rise to new species. Darwin acknowledged the paucity of the fossil record, and based much of his work on studies of living species, including his own work in the Galapagos Islands. The book is characterized by conservative conclusions backed up by numerous and painstakingly detailed examples and observations, and Darwin devoted three major chapters to discussion of problems and criticisms.

Ayala, Francisco J., "The Mechanisms of Evolution," Scientific American 239:56-69, September, 1978.

Natural populations possess an enormous amount of variability, especially plants and invertebrates. This variation is stored in genes, which are segments of DNA molecules (which are in turn combinations of four basic structure units called nucleotides). The DNA serves as a pattern or template for the formation of proteins from amino acids. A mutation is an error in the duplication of DNA, often the substitution of one nucleotide for another. This can result in the substitution of one amino acid for another in a protein (a point mutation). Many point mutations have no effect, since several different DNA patterns can produce the same amino acid. Mutations result from radiation, elevated temperature, chemical agents, and other causes. DNA mutations in reproductive cells can be passed to the next generation. In a large population there will be a few mutations per generation in each gene. Most mutations are kept in the gene pool at low frequencies. Evolutionary histories can be formed from studies of protein mutations, Ayala concluded.

Callaghan, Catherine A., "Evolution and Creationist Arguments," The American Biology Teacher 42:422-425, October, 1980.

Callaghan called the claim that Precambrian fossils are rare or nonexistant "long out of date." South African chert 3.1 million years old contained microfossils of bacteria- and algae-like organisms. Fossils of blue-green algae were found in 2.8 billion year old Rhodesian limestone. Oxidized sedimentary layers 1.8 to 2 billion years old document the production of oxygen by photosynthetic plants. Microfossil ecologies were located in Canada's 1.6 to 2 billion year old Gunflint formation. Nine hundred million year old Australian chert contained spores in the process of division. Fossil burrows in Australian sandstone show wormlike animals lived 800 million years ago. Callaghan pointed out that the "sudden" appearance of lifeforms in the Cambrian era actually spans 150 million years.

Considine, Douglas M., ed., "Evolution," Van Nostrand's Scientific Encyclopedia, Van Nostrand Reinhold, New York, 1976, 2370 pp.

All life displays biochemical unity. This unity includes (1) lipid-protein membranes for structure inside the cell, (2) the control of activity by enzymes, (3) all proteins are made up of the same small group of amino acids, (4) all genetic information is coded in DNA and RNA, (5) ATP is used to store energy, and (6) ATP and proteins are formed by a common series of chemical reactions. The external differences in organisms are less significant than their biochemical similarities.

Dobzhansky, Theodosius, "Nothing In Biology Makes Sense Except in the Light of Evolution," The American Biology Teacher 35:125-129, March, 1973

Earth's organic diversity makes sense only as a response to Earth's environmental diversity, asserted Dobzhansky. Unoccupied niches and environmental changes present challenges. One species of fungus grows only on the rear portion of a beetle which only lives in certain caves in France. One species of fly lives and feeds in crude oil seepages in California; it is found nowehere else. Two million species have been described and studied, and as many wait to be identified. Most evolutionary lines end in extinction, and yet the number of living species grows. Underneath the diversity of life is remarkable unity. Dobzhansky concluded that species are produced not for some purpose but because there is an environmental opportunity, and the biochemical unity is evidence of the common ancestry of all species.

Huxley, Julian, Evolution: The Modern Synthesis, George Allen and Unwin, Inc., London, 1974, 645 pp.

Huxley offered several examples of observed speciation. In the case of the house sparrow (Passer domesticus), the cause was adaptive radiation (the organism moving into a new range). The house sparrow was introduced to North America in 1852, and in less than thirty years in some instances developed distinguishable geographic races. Formation of new species through reproductive isolation was observed in the adaptation of the grass Agrostis tenuis to life on piles of poisonous mining wastes in North Wales. The plants that can grow on the contaminated soil flower earlier and self-fertilize more than the non-tolerant plants of the same type only meters away on normal soil, effectively separating them into two distinct gene pools.

Lewin, Roger, "Evolutionary Theory Under Fire," Science 210: 883-887, November 21, 1980.

Lewin reported on the disagreements among evolutionists that surfaced at a conference on macroevolution. Participants at the conference (including Gould, Ayala, and Stebbins) clashed on the tempo and mode of evolutionary change, and on the question of limits on the form of new species. Proponents of the Modern Synthesis (gradualism) held that gradual accumulations of mutations accounts for new species, though they accepted the concept of stasis (stability over time). The competing theory is known as punctuated equilibrium: relatively rapid (50,000 years) change "punctuating" a pattern of stability. According to Lewin, many participants felt the conference contributed to reconciliation of the two models.

"Statements by Scientists in the California Textbook Dispute," The American Biology Teacher 34:411-415, October, 1972.

The proposed science framework for California schools asserted that there is a regular absence of transitional forms (which statement was added by nonscientists over the objections of the science advisory committee). Stebbins testified that transitional forms between amphibians and reptiles were common during the Carboniferous Period. Animals transitional between reptiles and mammals dominated a 100-million year portion of the Permian and Triassic Periods. Archaeopteryx was in nearly all characteristics intermediate between reptiles and birds, according to Stebbins, and Homo habilis was in every observable characteristic a transition from apelike animals to humans.

Valentine, James W., "The Evolution of Multicellular Plants and Animals," Scientific American 239:140-158, September, 1978.

Valentine stated that with the exception of the fungi, the multicellular kingdoms have a rich fossil record. The earliest animal fossils appear in late Precambrian rocks. Phylogenetic trees can be constructed from fossils, morphology, and comparative embryology. The article included phylogenetic diagrams for fish, reptiles, mammals, and land plants. Several periods of rapid diversification were noted: of animals in general in the Cambrian, of flowering plants in the Cretaceous, of dinosaurs in the Triassic. Some environmental changes contributing to evolution are mountain-building, continental drift and fragmentation, changing wind patterns, and the rise in atmospheric oxygen due to photosynthesis. Over time the number of distinctive groups of organisms declines, while groups that survive become more diverse.

Villee, C. A., and Dethier, V. G., Biological Principles and Processes, W. B. Saunders Co., Philadelphia, Pennsylvania, 1971, 492 pp.

The authors summarized basic evidence for evolution. Fossils give the details of the phylogeny of many animals and some plants, but fossils are not needed to prove that evolution has occurred. Classification is possible only because species are related. Otherwise, characteristics would be confused and no hierarchy could be developed. Homologous organs, such as the forelimbs of the seal, bat, cat, horse, and human, show adaptation from a common origin. Human vestigial organs (the coccyx, wisdom teeth, nictitating membrane of the eye, body hair, etc.) show adaptation to a changing environment. Blood and enzyme chemistry provides independent confirmation of phylogenies constructed from fossils and other data. Urinary systems and wastes also show evolutionary relationships. Different groups of organisms produce uric acid, allantoin, urea, and ammonia, and some recapitualtion is seen in embryos. The authors concluded that the evidence for evolution is overwhelming.

Wilson, Edward O., and others, Life On Earth, Sinauer Associates, Stamford, Connecticut, 1973, 1033 pp.

Wilson defined evolution as a change in gene frequencies. There are four agents of evolution. Sexual reproduction is not one; it creates the diversity. The first agent is mutation pressure, which arises from point mutations (nucleotide substitutions in DNA) and from chromosomal abberrations: increased number, fusion of previously separate chromosomes, deletion of segments, duplication of segments, inversion of segments, and transfer of segments between chromosomes. Polyploidy, or duplication of the full set of chromosomes, gives rise to new plant species. The second agent is genetic drift, the random change of gene frequencies in small populations. A third agent is gene flow, the addition of new genes to the gene pool due to immigration. The final agent is natural selection, which has three distinct forms and is generally the most important of the four agents.

THE ORIGIN OF HOMO SAPIENS

Special Creation

Morris, Henry M., "The Tenets of Creationism," Impact 85:1-4, July, 1980.

The ICR's formal tenets for scientific creationism specify that the first humans were specially created and did not evolve from animals. The spiritual nature of humans (defined as "self-image, moral consciousness, abstract reasoning, language, will, religious nature", p.3) is a separate, supernaturally created entity. Disease, aging, and other imperfections show that the originally perfect creation has been impaired. The tenets of Biblical creationism expanded on this position, asserting that Adam and Eve were the first humans, and that the impairment of creation (including the introduction of death) is the result of sin. [Morris stated in conclusion that, "All the genuine facts of science support Biblical creationism, and all statements in the Bible are consistent with scientific creationism." (p.4, emphasis added)]

Heinze, Thomas F., Creation Vs. Evolution Handbook, Baker Book House, Grand Rapids, Michigan, 1978, 114 pp.

Observing that Piltdown man was a hoax and Nebraska man turned out to be a pig, Heinze concluded that what is presented today as evidence for human evolution is invented--tiny pieces of bone creatively interpreted. Heinze suggested that bones of living humans could be used to construct a phylogeny, and that burial ceremonies may have put bones into older strata, making them appear more ancient than they really were. According to Heinze, all that can be reliably said about the Australopithecines and Homo erectus is that they once lived and are now extinct, and he suggested that they may have been degenerate forms of Homo sapiens. Heinze cited the misinterpretation of Neaderthal man as further evidence of the unreliability of human paleontology. Noting that Neanderthal man had a larger brain case than modern man, Heinze wondered why the Neanderthals hadn't invented cities and civilization. Heinze opined that Cro-Magnon cave paintings are too bright, pretty, and skillful to have been done 20,000 years ago.

Levitt, Zola, Creation: A Scientist's Choice, Victor Books, Wheaton, Illinois, 1976, 132 pp.

In an interview and correspondence with Levitt, Moore complained that evolutionists place too much emphasis on similarities when comparing men and apes and too little on differences. Also, when comparing modern humans with supposed ancestral humanoids, evolutionists fail to allow for the fact that many features, including behavior, cannot be preserved for comparison. Moore offered a list of twenty differences between humans and apes, ranging from the placement of the nipple and the prominence of the lips to the relative length of the arms and the curvature of the spine.

The Evolutionary Phylogeny

Dobzhansky, Theodosius, and others, Evolution, W.H. Freeman and Co., San Francisco, California, 1977, 572 pp.

According to Dobzhansky, the evolutionary ascent of man is established without doubt, despite the fragmentary nature of some fossils and the needless proliferation of identifying names. The sequence Australopithecus→Homo habilis→Homo erectus→Homo sapiens is suggested, though Dobzhansky noted that new finds by Leakey in Africa may result in revisions. Dobzhansky reported that studies of hemoglobin show humans are most closely related to the gorilla, confirming studies based on external and internal anatomy. Humans and other animals share the basic biochemical identities; the most significant difference between the two is our brain size, which has led to restructuring of the skull, painful childbirth, and extended dependency by our offspring. Dobzhansky viewed humanity's most distinctive attribute to be culture--a store of information and behavior patterns transmitted nongenetically. Language is also a distinguishing feature, though chimpanzees [and gorillas] have been shown to have suprising language ability. Dobzhansky envisaged family ethics (taboo on infanticide, premium on child care) as products of natural selection, while group ethics (universal love, honesty, etc.) are products of cultural evolution.

Leakey, Richard E., Origins, E.P. Dutton, New York, 1977, 264 pp.

According to Leakey, three notable developments in human evolution were (1) freeing the hands for carrying objects (either through an erect posture or knuckle-walking), (2) the development of the precision grip (thumb-tip to finger-tip) as a companion to the power grip, and (3) language. Leakey credited stereoscopic color vision for making the higher primates object-conscious and -curious, and he emphasized the importance of primate studies in understanding human behavior and social organization. Recent finds of fossils of the genus Homo which which date back three million years have displaced the Australopithecines from the human ancestral path. Ramapithecus is now identified as the earliest human ancestor. Leakey conceded that final proof of a particular lineage and complete reconstruction of evolutionary history is probably impossible. Leakey noted that the intellectual gap between humans and other primates is much narrower than once thought, and suggested that the complexity of human and primate social interactions may have been an impetus to the evolution of intelligence.

Sagan, Carl, The Dragons of Eden, Random House, New York, 1977, 263 pp.

In Chapter 3, Sagan presented and discussed the model of brain evolution developed by MacLean. The model is based on studies of structure and function (behavior) in a variety of animals, and posits that the human brain is actually three brains, interconnected yet independent and representing successive stages in human evolution. The innermost brain, the reptilian or R-complex, is several hundred million years old, and controls aggressive behavior, territoriality, ritual, and the establishment of social hierarchies. Surrounding the R-complex is the limbic system, or mammal brain. The limbic system is the seat of emotions and child-care instinct. The neocortex is relatively new and makes up 85% of the brain; it handles various higher functions such as short-term memory, language, and spatial perception. The interplay of ritual (reptile), emotion (mammal), and reason (primate) was seen by Sagan as an explanation for many human behaviors.

Trivers, Robert L., "The Evolution of Reciprocal Altruism," The Quarterly Review of Biology 46:35-56, January, 1971.

Trivers presented a model which describes the natural selection of altruistic behavior. According to the model, a favorable ratio of cost (to the performer) to benefit (to the recipient) and the prospect of reciprocity give altruism survival value. Cheaters (non-reciprocators) are selected against. Animal behaviors explained by the model include warning cries of birds and cleaning symbiosis in marine animals. In humans, the emotions of friendship and hatred, moralistic aggression (both punishment and revenge), gratitude and sympathy, guilt and reparation, phoniness (a form of cheating), trust, and suspicion are all qualities that are linked to reciprocal altruism and are favored by natural selection. Trivers cited extensive anthropological and psychological data in support of the model.

Washburn, Sherwood L., "The Evolution of Man," Scientific American 239:194-208, September, 1978.

Washburn characterized the homonid fossil record as "generous." Homonids have walked upright for at least 3 million years, and a half million years later were making stone tools and hunting animals. Over the next million years a growth in brain size was paralleled by increasing complexity in the tools. Homo erectus, 1.5 million years ago, was the first true man, and Homo sapiens appeared 100,000 years ago. Modern humans appeared 40,000 years ago, and the transition from hunting to farming began 10,000 years ago. Molecular tests show that man and the chimpanzee share 99% of their genetic material. Primate field studies have show that tool-using is common. Primate language studies have narrowed the intelligence gap. Washburn suggested that the development of speech was the factor which stimulated cultural evolution.

EARTH'S CHRONOLOGY AND GEOLOGY

Catastrophism and a Young Earth

The Holy Bible: Revised Standard Edition, A.J. Holman Co., Philadelphia, Pennsylvania, 1962, 1172 pp.

Genesis 6:5 to 9:18 contained the account of the Noachian flood [held by the CRS to be a historic, worldwide event]. Following God's instructions, Noah built a three-deck ark of gopher wood and pitch in order to save his family and the world's fauna from a flood that will "blot out man." He took aboard seven pairs of all clean animals and birds, and one pair of all unclean animals. Forty days of continuous rain flooded the earth to the extent that "all the high mountains" were submerged. After 150 days, the ark went aground on Mt. Ararat. Noah released a raven and two doves at intervals to see if the waters had subsided. One year and ten days after the rains had begun, the earth was dry and Noah released the animals. Noah made a sacrifice ("burnt offerings on the altar," 8:20), and God established the rainbow as a sign of his promise never to flood the earth again.

Whitcomb, John C., Jr., and Morris, Henry M., The Genesis Flood, Baker Book House, Grand Rapids, Michigan, 1977, 518 pp.

The authors proposed a five-stage geologic history of the earth: the inital creation of a planet covered with oceans; the Creation week, wherein dry land, erosion, and soil arose; the antediluvian period, during which there was no rainfall and the waters were divided between the surface and the high atmosphere; the Flood, which laid down most sedimentary strata and was the most significant geologic event in earth's history; and the modern post-Deluge, characterized by limited uniformitarianism. The authors insisted that geologic data must be interpreted in light of the Biblical accounts, and the text was rich with Biblical references.
[Plate tectonics, which reshaped the science of geology in the 1960's, is not dealt with in this book--a glaring omission for a book that manages to discuss the Van Allen radiation belts and the origin of snow. The index entry for Man says "see Adam."]

Cumming Kenneth B., "Extinction," Impact 84:1-4, June, 1980.

Cumming identified four major periods of rapid extinction: of the trilobites at the end of the Cambrian Period, of reptiles at the end of the Triassic, of dinosaurs at the end of the Cretaceous, and of one-half of all species at the end of the Permian. According to Cumming, no satisfactory explanation has been offered by evolutionists. Climatic change is frequently cited but is still speculative. Cumming stated that creationists would predict extinction without replacement and an overall decrease in the number of taxonomic (classification) groups. He asserted that the fossil record confirms that prediction and supports the occurrence of a world-wide catastrophe.
[Only by isolating the higher taxa (phylum, class, and order) from the lower could Cumming make the data support his prediction. The graphs for families and species show a steady, sizable increase in diversity.]

Morris, Henry M., ed., Scientific Creationism (Public School Edition), Creation-Life Publishers, San Diego, California, 1974, 217 pp.

In the chapter "Old or Young?", Morris noted that since real history (i.e. written records) can only take us back to 3500 B.C., everything prior to then must be guessed at. According to Morris, the only method actually used to date rocks is the unreliable method of index fossils. Morris called this circular reasoning. Morris questioned the accuracy of radiometric dating on three grounds: elements may move in or out of the sample over time; the rate of decay must be assumed to be constant; and the decay product(s) may have already been present in the sample. According to Morris, the small amount of helium in the atmosphere, the absence of a thick layer of meteorite dust on the earth's surface, the mineral content of the ocean, and the decay of earth's magnetic field all argue for a young earth. He also asserted that the evolutionary time sequence is confused, since dinosaur and human footprints have been found together in limestone in the Paluxy River, Glen Rose, Texas (also discussed in Whitcomb and Morris 1977).
[The film of the discovery of the Paluxy fossils ("Footprints in Stone," Films-For-Christ, Elmwood Illinois) shows the use of bulldozers and large hand tools in the excavation. Standard field practice calls for soft brushes, small tools, and inch-by-inch documentation. Also, though Morris criticized radiometric dating on the basis that the decay rate had to be assumed to be constant, the magnetic-field study he cited in support of a young earth uses the same type of assumption.]

Coffin, Harold G., Creation: Accident or Design?, Review and Herald Publishing Association, Washington D.C., 1969, 512 pp.

According to Coffin, the rates of radioactive decay can logically be expected to be as dependable as the basic characteristics of the physical universe and to provide a reliable measure of time. When proper allowances are made for variables, seven independent radiometric methods find the Earth's rocks to be very old. Consequently, the Creation story in Genesis refers to the modification of an existing planet and the placing of life thereon. Coffin asserts that when an interpretation of data contradicts "inspired testimony," more research is needed, since the book of nature and the book of God should agree. For example, radiocarbon dates appear to conflict with Earth's history as described by Genesis and the Apostle Paul. Coffin suggested that the pre-Flood atmosphere had a low level of carbon-14 activity and that the dates are therefore inaccurate.
[This book represents the Seventh-Day Adventist version of creationism.]

Uniformitarianism and an Old Earth

Magnusson, Magnus, Archaeology of the Bible, Simon and Schuster, New York, 1977, 239 pp.

Magnusson stated that there is evidence cave-dwelling humans lives in northern Israel's Valley of the Caves tens of thousands of years before the purported date of Genesis. The ruins of Jericho date from 8000-10,000 B.C. Magnusson pointed out that Sumerian creation myths are very similar to and predate the Biblical story of creation. A Sumerian Flood myth describes how a king of Uruk named Gilgamesh was forewarned when the Sumerian gods decided to destroy humanity with a flood because humans had become too noisy and numerous. Gilgamesh is instructed to build a huge cube-shaped vessel and take aboard it "the seed of all living things." Rain falls for seven days. Gilgamesh's vessel comes to rest on Mt. Nisir, and he sends out a dove, a swallow, and a raven as scouts. After the flood subsides, Gilgamesh offers a sacrifice to the gods. The Biblical flood story is a modification (the polytheism removes) and the locale shifted) of this earlier Sumerian account, according to Magnusson.

Jukes, Thomas H., "Two By Two," Nature 285:130, May 15, 1980.

Jukes examined the implications of taking the story of Noah literally. The volume of the Ark, based on the dimensions in the Bible, was 43,800 cubic meters. It would have been necessary to provide room for Noah's family, 1 million insect species, 25,000 bird species, 8,500 types of amphibians and reptiles, 15,000 mammal species, and supplies for 375 days. Less than a cubic meter would be available for each pair of vertebrates plus their food supply. Other related problems identified by Jukes include the disposal of wastes, the preservation of microorganisms, the preservation of plants, and predation of one species on another. Moreover, to flood the earth to a depth of just 10,000 feet (Mt. Ararat is 17,000 feet high) 393 million cubic miles of additional water would be needed--1.4 times the amount on the earth today. The daily rainfall would have been 104 feet, and it had to dry up in just 167 days. Jukes implied that these are insurmountable problems.

Cloud, Preston, "'Scientific Creationism'--A New Inquisition Brewing?" The Humanist 37:6-15, January/February 1977.

Cloud reported that creationists insist that all fossils were deposited during the Flood [shells in lower layer because they are streamlined, mammals in higher layers because they could run away]. Cloud argued that the volume of sediment involved makes this impossible. Continuous sedimentary strata are as thick as 12 miles, and a youngest-to-oldest aggregation would be much thicker. Depositing even twelve miles of sediment would require 32,000 years. Cloud pointed out that pre-radiometric dating of the earth by the rate of sedimentation produced ages in excess of 100 million years. The legend of a great lowland flood may trace to a real event; Emiliani has collected evidence for the rapid melting of a glacier in the late Pleistocene, approximately 11,600 years ago.

Milne, David H., "How to Debate With Creationists--and 'Win'," The American Biology Teacher 43:235-245, May, 1981.

Milne reviewed the evidence concerning supposed human footprints in the Paluxy River, Glen Rose, Texas. The footprints show a seven-foot stride, and some prints are 21 inches long. According to Milne, the "human" prints are very similar to toe marks in true dinosaur prints, and some of the "human" prints show a large rear claw and an "instep" on the outside edge of the foot. Milne observed that relevant portions of some photographs are obscured by sand. Based on information from W. Langston, Milne suggested that some of the tracks were carved by a local prankster.

Flint, Richard F., and Skinner, Brian J., Physical Geology, John Wiley and Sons, New York, 1974, 497 pp.

The authors argued that the rock cycle and plate tectonics account for the present appearance of the Earth's surface. A comparison of old rocks with recent ones justifies the principle of uniformity. The fact that fossil faunas and floras succeed each other in a definite order was a useful principle prior to evolutionary theory. Radiometric dating is based on processes which run continuously and are not influenced by external conditions. The authors explained that igneous rocks are dated directly, while sedimentary rocks are bracketed between nearby igneous intrusions Flint and Skinner pointed out that the geologic column, formulated in the 19th century, was confirmed by radiometric dating in the 20th century. The earth's age was reported to be approximately 4.6 billion years.

Press, Frank, and Siever, Raymond, Earth, W.H. Freeman and Co., San Francisco, California, 1974, 945 pp.

The authors clarified the fact that uniformitarianism applies to the physical and chemical laws, and not to the rates of processes such as volcanism. The presence of occasional gaps in the geologic column was explained by erosion or non-deposition (such as in shallow ocean basins where erosion and deposition balance each other). The following potential errors in radiometric dating were discussed: removal of an end product, which results in underestimates; "resetting" the radiometric clock through metamorphism, which results in underestimates); and interpreting the event that started the clock. The authors reported that rocks on earth range in age from 0 to 3.7 billion years old. Moon rocks range from 3.1 to 4.5 billion years old. Meteorites, regardless of their composition, all date back 4.6 billion years. The authors concluded that the formation of the Earth and the solar system took place approximately 4.6 billion years ago.

Mitton, Simon, ed., The Cambridge Encyclopedia of Astronomy, Crown Publishers, Inc., New York, 1978, 481 pp.

Mitton offered some age measurements based on astronomical techniques, mostly non-radiometric. Open clusters of stars are more than 100,000 years and less than 100 million years old. Cosmic rays, which are produced by supernovae, are from 3 to 10 million years old. Three independent methods fix the age of our Galaxy at about 10 billion years, and the globular clusters would have formed at the same time. The fact that we can see quasars, which are up to 8 billion light-years away, argues for a very old Universe. The sun is at least 4.65 billion years old, and rocks from the lunar highlands are 4 billion years old. The rate of expansion of the universe suggests that the big bang took place 15 billion years ago.
[Whitcomb and Morris (1977:368) sidestep the expansion and quasar evidence by suggesting the universe was created old--that is, in mid-expansion with light from distant objects already en route.]

SUMMARY

Creationists Moore and Bird asserted that evolution has not been and cannot be demonstrated experimentally. Therefore, in their view, evolution is not a scientific theory but a model supported by circumstantial evidence. According to Gish and Popper, falsifiability is the key criterion for a scientific theory, and Gish argued that evolution does not meet that criterion. Bird asserted that scientific creationism is not religious.

According to Gould, Alexander, Hanson, Patterson, and Darwin, evolution is eminently falsifiable, and in support of that contention Alexander, Hanson, Patterson, Anderson, and Walker iterated ways in which evolution has been empirically tested. It was the contention of Kyle, Walker, and Mayer that appeals to the supernatural are antithetical to the nature of scientific inquiry. Gould, Alexander, and Kyle pointed out that the creationists' appeal to the supernatural makes creationism unfalsifiable, and Gish agreed. Peters identified the religious components of creationism, and LeClercq and Skoog reported that the courts have consistently found creationism rather than evolution to be a religiously-based doctrine.

On the question of the universe's origin, Morrison, Gish, and Parker claimed that design--and thereby a designer --can be observed in the structure and perfection of the natural world. But Aulie argued that the perception of

design is subjective and emotional, and Stebbins and Lewontin showed that apparent design can be explained by adaptation and structural chemistry. According to the CRS members and Riegle, the Bible is a completely reliable source of historic and scientific information. Kenyon and Speiser reported, however, that the vast majority of Bible scholars agree that Genesis is a composite myth with multiple authors. Jastrow pointed out that the Bible and big-bang cosmology both postulate a sudden, definite beginning for the present universe, but Weinberg and Sagan made clear that that is the only point of correspondence.

The laws of probability and thermodynamics make a mechanistic origin of life impossible, said Bliss, Gish, and Morris. Asimov demonstrated that such statements were based on false assumptions, and Miller, Fox, and Dickerson reported on experiments which support the synthesis of life from non-life. The formation of complex organic molecules was found to be a rather ordinary event.

According to Lester, Moore, Morris, and Gish, the outstanding features of the fossil record are a lack of transitional forms and stability over time. Consequently, they said, the fossil record supports the idea that the various kinds of organisms were created separately. Callaghan, Stebbins, and Valentine disputed the assertion that transitional fossils are lacking, while Dobzhansky, Huxley, Considine, and Villee and Dethier cataloged a variety

of observations supporting the relatedness of species, including examples of speciation.

Morris, Heinze, and Moore (in Levitt) argued for a separate origin for humans and other primates, and Morris (speaking for the ICR) stated that the first humans were specially created and that human qualities such as moral consciousness and abstract reasoning are of non-mechanistic origin. But according to Leakey, Dobzhansky, and Washburn, the perceived gap between the other primates and humans has been effectively eliminated by evidence from primate field studies, biochemistry, and genetics. Dobzhansky and Leakey outlined the fossil evidence for human evolution, and Sagan and Trivers described models detailing the evolution of reasoning and a variety of social-emotional behaviors.

A recent worldwide flood, said Whitcomb and Moore, Harding, and Cumming, best accounts for the creation of fossils and sedimentary strata, and Morris contended that the dating methods which suggest an ancient earth are unreliable. Coffin, however, conceded the accuracy of radiometric dating, while holding out for a recent Flood and origin of life. But Cloud and Magnusson asserted that the Biblical flood story is a myth drawn from Sumerian tradition, while Cloud and Jukes identified the too-small volume of the ark and the too-great volume of the sediments among problems engendered by taking the Noachian account literally. The rock cycle and plate tectonics can best account for the

earth's geology, according to Press and Flint, and they plus Mitton identified a variety of independent dating methods which agree on the antiquity of the earth and the universe.

CONCLUSIONS

The key creationist claim is that creationism is deserving of equal status with evolution. If they can show that creationism should be elevated to the level of a scientific theory, or that evolution should be demoted to the level of a faith-based model, equal-time in the curriculum becomes a fait accompli.

In their arguments, creationists unabashedly invoked the supernatural, accepted a priori the Bible as a source of immutable fact, and offered telelogical explanations of natural phenomena. These three practices fatally undermine any claim that creationism is a scientific theory, a point which was conceded by some creationist sources. Consequently, the creationists endeavored to show that evolution also does not meet the criteria for a scientific theory, particularly the criterion of falsifiability. But evolutionists beginning with Darwin were able to identify tests or observations which had the potential to falsify evolutionary theory. The creationists' attempt to distinguish between experiment and conclusive evidence on the one hand, and observation and circumstantial evidence on the other was rightly rejected by the evolutionists as a false dichotomy.

The difference between the two models was evidenced by the tone of their supporters work. Creationist writings were characterized by absolutism and finality; evolutionist writings were tempered by cautionary statements. Creationists frequently glossed over, ignored, or denied troublesome data; evolutionists

commonly attempted to integrate such data. Creationists tended to deny the possibility of error, while evolutionists tended to acknowledge the limitations of the data or method. The seemingly inescapable conclusion is that there remains a qualitative difference between the doctrine of special creation and the theory of evolution.

The remainder of the creationist position may be characterized as a body of criticism, rather than the explication of a cogent model. Most of the criticisms do not survive close scrutiny. As discussed above, the arguments from design and from authority are inadmissable. The objections to a mechanistic origin of life drawn from probability and thermodynamics were specious. The concept of "fixity of kinds" was, in light of the creationists' inability to define a "kind", a panchreston--a wild-card which permitted the creationists to negate any observation of transition in a species by describing it as change "within" a kind. The creationists' dismissal of structural and chemical homologies as the result of a common plan begged the question.

The most-repeated creationist criticisms concerned the fossil record--not surprising, since evolutionists themselves are somewhat divided on whether the fossil record is accurate and complete or biased and incomplete. But the evolutionists involved in the disagreement are not questioning the process of evolution; they are grappling with the difficult task of delineating a particular evolutionary path. Some of the

creationist criticisms of proposed phylogenies may be valid, especially inasmuch as many of those criticisms are borrowed from evolutionists themselves. But the claim that the fossil record does not contain evidence of evolution having taken place (except within the infinitely flexible "kinds") proved to be extreme and untenable.

Creationists attempted to show that a sharp line exists between man and the rest of the primates, and disparaged the various human fossils by catagorizing them as misidentified apes, degenerate humans, or frauds. But to maintain the distinction, the creationists ignored or dismissed corroborating evidence from morphology, biochemistry, genetics, and primate studies. It is certainly permissible to view man as above and apart from the rest of nature, but the justification for such a view must come not from science but from appeals to the Bible's authority, God's design, and/or mankind's vanity.

Lastly, many independent dating methods conferred great antiquity upon the earth. Though each method has its limitations and variables and though the order of magnitude of the numbers provided may be beyond meaningful comprehension, their combined testimony was compelling. An ancient, slowly-changing earth, the shape of its crust testimony to the interplay of rock cycle and water cycle, provided the most self-consistent explanation for the geology of the earth today.

RECOMMENDATIONS

It is recommended that:

1. Legislatures, school boards, and individual teachers refuse requests to add scientific creationism to the science curriculum as an alternative model to evolution.
2. Evolution be used as the organizing principle of secondary biology courses in particular and of life science instruction in general.
3. The nature, requirements, and limitations of the scientific process be given increased emphasis throughout science teaching. Science must be presented as a framework for asking questions, rather than merely a set of fixed answers.
4. Any consideration of the doctrine of special creation in the public schools be in the context of a comparative study of religions, a history of religion, a history of science, or philosophy.

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APPENDICES

APPENDIX A

Scientific and Creationist Organizations

1. American Association for the Advancement of Science (AAAS)
   1515 Massachusetts Avenue N.W.
   Washington, D.C. 20005
   202-467-4400
   William D. Carey, Executive Director

Founded in 1848, the AAAS is the largest general-science organization in the United States, with 130,000 individuals and 285 societies and organizations as members. The AAAS is organized into 22 sections representing the major scientific disciplines. Its five regular publications include Science (weekly journal), Science 81 (monthly general-circulation magazine), and Science Education News. The AAAS has a staff of 171.

2. Bible-Science Association (BSA)
   2911 East 42nd Street
   Minneapolis, MN 55406
   Rev. Walter Lang, Executive Director

Founded in 1964, the BSA is a organization of religious, lay, and scientific people who wish to have the Biblical story of creation taught in schools. The BSA has a staff of 7, a membership of 3000, and claims a mailing list of 35,000 for its monthly Bible-Science Newsletter. Founder Lang formed the BSA after finding that Idaho college students he knew were losing their faith as a result of evolution. The BSA maintains a library of creationist materials, conducts educational programs, and publishes six weekly creationist publications for grades 1-9.

3. Biological Sciences Curriculum Study (BSCS)
   University of Colorado
   Boulder, Colorado 80302
   William Mayer, Director

The BSCS was established in January, 1959 by the American Institute of Biological Sciences (~9,000 members) with financial support from the National Science Foundation (see below). The BSCS is a cooperative effort between high school biology teachers, university researchers, and professional biologists to produce up-to-date, accurate curriculum materials. The first editions of the BSCS texts were tested in 100 schools during 1960-1961. The three BSCS versions are known as the Blue, Yellow, and Green: respectively, their titles are Biological Science: Molecules To Man, Biological Science: An Inquiry into Life, and High School Biology.

4. Creation Research Society (CRS)
2727 Cranbrook Road
Ann Arbor, Michigan 48104
313-971-5915
Dr. Wilbert Rusch, Sr., Membership Secretary

Voting members of the CRS must have an advanced degree in a natural science and subscribe to a Statement of Faith which includes commitment to special creation and a worldwide flood and opposition to any form of evolution. The CRS was formed in 1963 by ten scientists, led by rose breeder Walter Lammerts, who were unhappy with the American Scientific Affiliation's refusal to disavow evolution. Current membership is 600 voting and 1900 associate. CRS members make up most of the staff and membership of the ICR and CSRC. The goal of the CRS is to conduct creationist research and to disseminate information to the public; it publishes a journal, the Creation Research Society Quarterly.

5. Creation Science Research Center (CSRC)
San Diego, California
Kelly Segraves, Director
Nell Segraves, administrator
Robert Kofahl, science adviser

The CSRC was founded in 1970. It has a staff of 8 and a mailing list of "thousands" for its monthly newsletter, the Creation Science Report. According to Nell Segraves, the CSRC was founded in order that "every man who comes in contact with the truth of creation must in reality come in contact with the One Who is the Creator, Jesus Christ." The CSRC has played a major role in the effort begun in 1963 by Nell Segraves and others to obtain equal time for evolution in California science classes. The CSRC's involvement in right-wing issues such as sex and drug education, abortion, ERA, and Planned Parenthood is reportedly an embarrassment to other creationist organizations.

6. Institute for Creation Research (ICR)
2716 Madison Avenue
San Diego, California 92116
714-440-2443
Henry M. Morris, Director
Duane Gish, Associate Director
Richard Bliss, Director of Curriculum Development

The ICR was established in 1973 as the research and publishing arm of Christian Heritage College (founded 1970, 1980 enrollment 200). It has a staff of eleven, most of whom are also professors at the college. ICR activities include a weekly radio broadcast, workshops, and debates. Research projects include a search for Noah's Ark, field studies of inverted geologic sequences, and critiques of evolution. Its monthly publications are Impact and Acts and Facts.

7. National Association of Biology Teachers (NABT)
   11250 Roger Bacon Drive
   Reston, Virginia 22090
   703-471-1134
   Wayne M. Moyer, Executive Director

The NABT was founded in 1938 as the professional society for secondary and college biology instructors, and identifies as its goal "scientific literacy among citizens." The NABT has a staff of 7 and a membership of 6000. Its publications are The American Biology Teacher (nine times yearly), and News and Views (bimonthly).

8. National Science Foundation (NSF)
   1800 G Street, N.W.
   Washington, D.C. 20550
   202-655-4000
   Dr. Richard Atkinson, Director

The NSF was established in 1950 as an independent agency in the executive branch of the federal government. Its primary concern is to provide support for basic and applied research and for education in the sciences. In the latter area, the NSF works to develop up-to-date science course materials, encourage the exchange of information, and provide educational opportunities for teachers, graduate students, undergraduate students, and high school students of high ability. The NSF has a staff of 1200.

Primary Source: Akey 1980.

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APPENDIX B

The Geologic Column

ERA	PERIOD	EPOCH	DISTINCTIVE FEATURES	OROGENIES	YEARS BEFORE PRESENT (Millions)
CENOZOIC	QUATERNARY	HOLOCENE	Modern man	Cascadian	.01
		PLEISTOCENE	Early man; glaciation		2.5–3
	TERTIARY	PLIOCENE	Large carnivores		7
		MIOCENE	Abundant grazing animals		26
		OLIGOCENE	Large running mammals		37
		EOCENE	Modern types of mammals		54
		PALEOCENE	First placental mammals	Laramide	65
MESOZOIC	CRETACEOUS		First flowering plants; climax of dinosaurs and ammonites, followed by extinction	Nevadan	135
	JURASSIC		First birds: first true mammals. Many dinosaurs and ammonites		180
	TRIASSIC		First dinosaurs; abundant cycads and conifers	Palisades	225
PALEOZOIC	PERMIAN		Extinction of many types of marine animals, including trilobites	Alleghanian	280
	PENNSYLVANIAN	CARBONIFEROUS	Great coal swamps; conifers. First reptiles		310
	MISSISSIPPIAN		Sharks and amphibians Large scale trees, seed ferns		345
	DEVONIAN		First amphibians; fishes very abundant	Acadian	400
	SILURIAN		First terrestrial plants		435
	ORDOVICIAN		First fishes. Marine invertebrates dominant	Taconic	500
	CAMBRIAN		First abundant record of marine life. Trilobites and brachiopods dominant		600
PRECAMBRIAN	LATE		Fossils generally rare Continental glaciation	Grenville Keweenawan igneous activity	
	MIDDLE		Iron formations Continental glaciation	Penokean	
	EARLY		Oldest algae—3.2 billion years Oldest dated rock—3.5 billion years	Algoman Laurentian	

CONTINENTAL GLACIATION IN SOUTHERN HEMISPHERE

APPALACHIAN OROGENY

Source: Zumberge and Nelson:331

APPENDIX C

Highlights the Evolution/Creation Controversy

1809 Jean-Baptiste Lamarck presents the first complete theory of evolution in his book Philosophie Zoologique.

1858 Charles Darwin and Alfred Russel Wallace present papers on natural selection at a meeting of the Linnean Society in London.

1859 The first edition of Darwin's The Origin of Species sells out on the day of publication.

1860 Thomas Huxley is the clear victor in a debate with Bishop Wilberforce at Oxford on the question of evolution vs. creation.

1871 The first edition of Darwin's The Descent of Man is published.

1920-1929 Thirty-seven bills outlawing the teaching of evolution in public schools are proposed in twenty states. Three pass: Tennessee (1925), Mississippi (1926), and Arkansas (1927).

1925 John T. Scopes goes on trial in Dayton, Tennessee, in a deliberate test of the 1925 Tennessee anti-evolution law. Though Scopes' lawyer, Clarence Darrow, brilliantly refuted prosecutor William Jennings Bryan's claims that the Bible could be taken literally, Scopes is found guilty and fined $100. The conviction is later set aside by a higher court on a technicality.

1930-1963 Textbook publishers avoid the topic of evolution and Darwin's name. Consequently, only one anti-evolution bill is introduced during this time.

1942 A national survey by Oscar Riddle finds that less than half the nation's high school biology teachers mention evolution in their classes.

***

Sir Julian Huxley, grandson of Thomas Huxley, publishes a definitive statement of the "new" evolutionary theory called Evolution: The Modern Synthesis.

1959 On the centennial of the publication of The Origin of Species, geneticist Hermann J. Muller complains that public school biology teaching is dominated by "antiquated religious traditions."

***

The National Science Foundation and American Institute for Biological Science set up the Biological Science Curriculum Study to produce up-to-date biology texts.

1963 Walter Lammerts founds the Creation Research Society.

***

Jean Sumrall and Nell Segraves petition the California State Board of Education to add the creation model to public school texts and classes.

1964-1978 Twenty-two bills requiring the teaching of creationism or forbidding the teaching of evolution are introduced in various state legislatures.

1964 The Rev. Walter Lang forms the Bible-Science Association.

***

The BSCS texts are introduced nationally after three years of testing and revision.

***

Norma Gabler campaigns unsuccessfully against the inclusion of the BSCS texts on the Texas state adoption list. In subsequent years Gabler will continue to monitor science textbooks and oppose those with a strong evolutionary content.

1967 The Tennessee antievolution law under which Scopes was convicted is repealed. Scopes is sent a copy of the repeal bill and comments, "Better late than never."

***

A bill is introduced in the Colorado legislature that would require creation to receive triple the time and money spent teaching evolution.

***

Cornelius Troost reports that only 33% of Indiana high school biology teachers consider evolution a fact, and 58% spend seven days or less on the topic.

1968 In Epperson vs. Arkansas, the 1927 Arkansas anti-evolution law is declared unconstitutional.

1969 The California Board of Education adopts a Science Framework calling for evolution and creation to be presented as alternative theories.

***

Two of the three BSCS editions fail to make the Texas adoption list.

1970-1977 The average number of words devoted to evolution in biology texts declines 15% from its peak in the 1960's.

1970 The Creation Science Research Center is founded in San Diego by Nell Segraves and her son Kelly Segraves.

***

California develops textbook selection criteria based on the 1969 Framework and requiring the equal treatment of creation and evolution.

1972 William Willoughby, religion editor of the Washington Star, files suit against the National Science Foundation over the NSF's support of the BSCS. Willoughby demands the withdrawal of the BSCS texts and the expenditure of an amount equal to the texts' development cost plus all profits ($7 million) in the promotion of creationism.

***

Duane Gish and John N. Moore present creationist papers at the NABT's national convention.

1973 The Institute for Creation Research begins operation.

***

Tennessee passes the first equal-time law.

1974 Responding to a Gabler proposal, the Texas Board of Education adopts a requirement that texts presenting evolution must treat is as only a theory and just one of several explanations of origins.

***

Teachers and scientists succeed in removing the creationist language from the California Science Framework.

1975 In a suit brought by the NABT, the U.S. Court of Appeals finds the Tennessee equal-time law "unconstitutional on its face."

***

The Indiana Commission on Text Adoption approves the placement of a creationist high school biology text on the adoption list. Seven school districts opt for it.

1977 All three BSCS texts fail to make the Texas adoption list.

***

The Indiana Superior Court finds the approval of the creationist text for use in Indiana to be in violation of both the state and Federal constitutions.

***

Nearly 200 professional scientists sign a statement directed toward school boards, teachers, and text publishers, affirming evolution as a principle of science and calling for refusal of equal-time requests.

1978 The National Fund For Fairness in Education files an unsuccessful suit against the Smithsonian Institute, requesting that work on a new exhibit hall for evolution be stopped and that the Institute spend as much on biblical creation as it does on evolution.

***

The new science framework adopted by California is challenged by creationists on the grounds it violates the Free Exercise rights of creationist students and families.

1979-1980 In a flurry of legislative activity, eleven bills calling for equal time for creation are introduced in various states.

1980 Candidate Ronald Reagan speaks out in support of equal time for creationism.

***

A Gallup poll finds that 58% of Protestants and 47% of Catholics believe that human life began with the creation of Adam and Eve by God.

1981 Kelly Segraves files suit in California to have the evolutionist language in the state curriculum guidebook changed. The court rules in favor of the state, but orders dissemination of a 1973 policy statement calling for the presentation of evolution as theory, not dogma.

***

Arkansas passes a law requiring that, beginning in 1982, wherever creationism or evolution is taught the other is to be given equal time.